Damcos A/S
Boeletvej 1
DK-8680 Ry
Denmark

T +45 5578 7200
F +45 8689 2280
E damcos.dk@emerson.com
W www.emersonprocess.com/mtm
CVR no. DK49698119

TANK CONTENTS TRANSMITTER MAS 2600

Installation & User Manual

Version 11UK-09.09

Table of contents

Description and Operation 3

MAS 2600 Tank Contents Transmitter 3
Application 3
Intrinsically Safe in Hazardous Areas 3
Type Approvals 3

Technical Specifications 4

MAS 2600 Ordering Information 5

Type 6
Measuring Ranges 6
Selecting the Measuring Range 7
Selecting the Transducer Type 7
Absolute Transducers 8
Basic Rules 8
Forepeak Tank 8
Draft 9
Temperature Sensor 9
Cable 9
Brackets for Internal Mounting - drawing no. G022P010 10
Pole Mounting - drawing no. G022P011 10
1” Pipe End Mounting - drawing no. G022P015 11
Flange Mounting - drawing no. G022P013 11
Flexible rubber tube mounting 80 12
Flexible PTFE tube mounting 12
DN25 flange with 1” ball valve – drawing no. G022P019 13
Amplifier Box 14
Amplifier PCB 15

Handling 16

Installation 17

Intrinsically Safe Installation 19

Testing and Recalibrating 21

Testing 21
Recalibrating Gauge Transmitter using Test Cup type G022S100 21
Recalibrating Gauge Transmitter using Vacuum (for gauge transmitters only) 22
Recalibrating the Absolute Transmitter using Test Cup type G022S100 23

Maintenance and Trouble Shooting 25

Maintenance 25
Trouble Shooting 25
MAS2600 Test sheet 26

Description and Operation

MAS 2600 Tank Contents Transmitter

The MAS 2600 is a 2-wire 4-20 mA level transmitter consisting of a transducer and an amplifier interconnected by a 6-core vented cable.

Transducer:
The transducer is a pressure sensitive silicon micro strain gauge sensor mounted in a glass to metal seal. The sensor is protected by an isolation diaphragm, electron beam welded to the transducer housing, with an oil filling between the sensor and the diaphragm. Pressure changes on the front of the diaphragm will bring a resistance change in the Wheatstone bridge of the transducer. This change in the Wheatstone bridge will be transmitted to the amplifier as a change in the electrical signal.

The transducer is fully welded, housed in titanium with a titanium diaphragm.

All transducer types are submersible (IP68).

The transducer is available in three versions:

- Gauge version.
- Absolute version.
- High temperature gauge version.

As optional the transducer is available with a built-in Pt100 temperature sensor.

Amplifier:
The amplifier is available in the following options:

- Programmable version: Calibration is made by dip switches and potentiometers.
- Fixed version: Calibration is done by means of a computer system, e.g. tank monitoring software.
- Differential version: For measuring of both pressure and vacuum measuring. Calibration is done by a computer system, e.g. tank monitoring software.

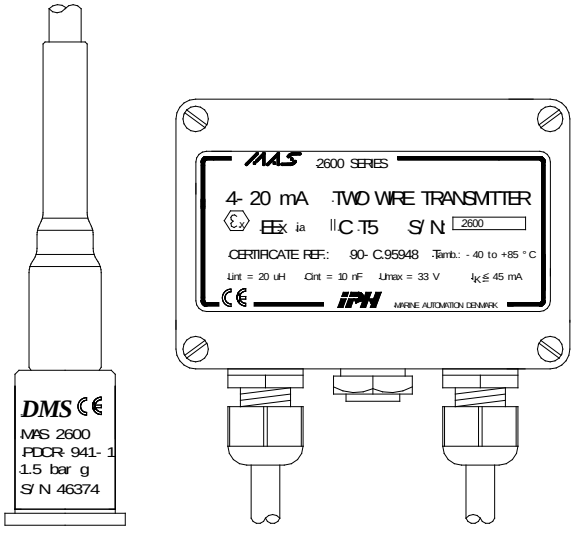
The amplifier is housed in a sea water resistant polyester casing (IP56).

Application
The MAS 2600 has been developed for level measuring in ballast, oil, service and fresh water tanks as well as tanks containing media which are not hostile to titanium.

Intrinsically Safe in Hazardous Areas
The MAS 2600 is DEMKO approved for use with standard transmitter zener barriers or Ex isolation amplifiers and is EEx ia IIC T5 compliant in accordance with CENELEC EN 50020.

Type Approvals
DNV, GL, LRS, MRS, BV, RINA, NK, PRS, KRS, ABS, MSA.

CE marked in accordance with EU directive.


DMS CE
MAS 2600
PDCR 941- 1
1.5 bar g
S/N 46374
MAS 2600 SERIES
4- 20 mA TWO WIRE TRANSMITTER
EEx ia IIC T5 S/N 2600
CERTIFICATE REF.: 90- C.95948 Tamb.: - 40 to +85 ° C
Uint = 20 uH Cint = 10 nF Umax = 33 V
MARINE AUTOMATION DENMARK

Transduce

Amplifier box

Technical Specifications

Transducer Ranges:
Gauge: 0-3.5 / 0-7 / 0-16 / 0-35 m H_2O.
Absolute: 0-20.394 / 0-35.690 m H_2O.

Programmable Measuring Ranges:
Each transducer range is programmable in 8 steps.

Accuracy:
± 0.25% F.S. at 20°C.

Stability:
Max. ± 0.1% / Year.

TEB (Total Error Band):
± 2.0% F.S. at -20 to +80°C.

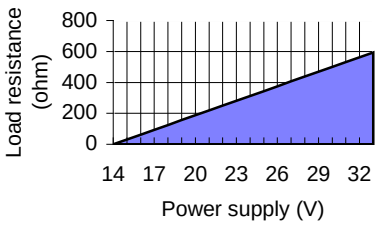
Overload Capability:
Min. 4 x transducer range with no changes in calibration.
6 x transducer range burst pressure.

Built-in Temperature Sensor Pt100:
Optional.

Power Supply:
The Power Supply can vary from 14-33 VDC. Permissible load resistance is shown graphically below. Calculation formula:

$$R_{loop\ max.}\ (\text{Kohm}) = \frac{U_{Loop} - 14V}{32mA}$$

Max. load resistance
at various power supply



Output Current:
4-20 mA DC, loop powered 2-wire system.

Current Limiting:
Max: 25 mA

Sensor Materials:
Housing: Titanium Grade 2
Diaphragm: Titanium Grade 4

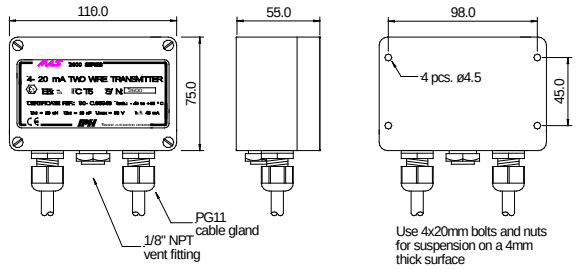
Operating Temperature Ranges:
Transducer: -20 to +125°C
Standard cable: -20 to + 80°C
High temperature cable: -20 to +125°C
Amplifier: -40 to + 85°C

Protection Class:
Transducer: IP 68
Amplifier: IP 56

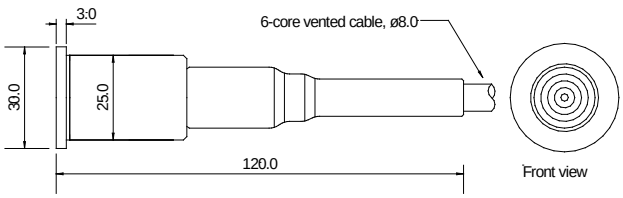
Intrinsic Safety:
EEx ia IIC T5 compliant.
Max. 75 m cable between transducer and transmitter amplifier.

Transmitter dimensions

Amplifier box:



Transducer:



MAS 2600 Ordering Information

Type
- A absolute transducer
- G gauge transducer
- H high temperature gauge transducer

Transducer Ranges
- 1 3,5 mH_2O gauge or high temp.
- 2 7,0 mH_2O gauge or high temp.
- 3 16,0 mH_2O gauge or high temp.
- 4 35,0 mH_2O gauge or 0,8 – 3,5 bar absolute
- 7 0,8 – 2,0 bar absolute

Temperature Sensor
- 0 without
- 1 Built-in Pt100

Cable
- XX XLPE standard cable length in meters (up to 80°C). Max. 300 meters
- XX FEP high temperature cable length in meters (up to 125°C). Max. 300 meters

Mounting
- 0 without fittings
- 1 brackets for internal mounting
- 2 pole mounting
- 3 1" pipe end mounting
- 4 flange mounting DN 25
- 5 flange mounting DN 40
- 6 flange mounting DN 50
- 9 flexible rubber tube mounting – 80 ºC (add length in meters)
- P flexible PTFE tube mounting – 125 ºC (add length in meters)
- V DN25 flange / 1” ball valve
- A-M replacement

Amplifier Box
- 0 not supplied
- 1 standard box with PG 11 / PG 11
- 2 standard box with PG 11 / PG 13,5
- 3 standard box with PG 11 / PG 16
- 4 silumin box type 2600 box-alu
- 5 standard box with PG 13,5 / PG 13,5
- 6 standard box with PG 11 / PG 11 – filling hole
- 7 standard box with PG 11 / PG 13,5 – filling hole
- 8 standard box with PG 11 / PG 16 – filling hole

Amplifier PCB
- 0 not supplied

without terminals for temperature sensors:
- P programmable output range gauge
- D differential output range gauge

with terminals for temperature sensors:
- S programmable output range gauge
- M differential output range gauge

X	X	X	-	XX	-	X	/	X	X

Type MAS 2600-XXX-XX-X/XX

A: Absolute Transducer. The absolute transducer has no breather pipe, because it refers to absolute vacuum. An atmospheric pressure sensor is used to compensate for the atmospheric pressure. The absolute transducer is especially suitable for open deck applications, where the amplifier box may be exposed to flooding.

G: Gauge Transducer. The gauge transducer is fitted with a breather pipe at the back of the diaphragm to compensate for the atmospheric pressure. The breather pipe is connected to a vent plug in the amplifier box. The gauge transducer is suitable for most applications.

H: High Temperature Transducer. The high temperature transducer is available in gauge version only. The transducer is mounted with a special high temperature cable and designed for heated tanks e.g. HFO tanks, and other applications with high tank media temperatures. The transducer can be flange mounted or internally mounted.

Measuring Ranges MAS 2600-XXX-XX-X/XX

Gauge Transmitter:
The MAS 2600 Gauge Transmitter is supplied in 4 ranges. In the programmable amplifier the measuring range is divided into 8 sub-ranges and operated by means of the range select switch.

The transmitter output signal can be adjusted to 20 mA within the following sub-ranges.

	Transducer type			
Range No.	**Type 1: 0 – 3.5 mH_2O**	**Type 2: 0 – 7.0 mH_2O**	**Type 3: 0 – 16.0 mH_2O**	**Type 4: 0 – 35.0 mH_2O**
1	0.20 – 0.37 mH_2O	0.20 – 0.30 mH_2O	0.50 – 0.75 mH_2O	1.00 – 1.90 mH_2O
2	0.37 – 0.54 mH_2O	0.30 – 0.50 mH_2O	0.75 – 1.00 mH_2O	1.90 – 2.80 mH_2O
3	0.54 – 0.73 mH_2O	0.50 – 0.70 mH_2O	1.00 – 1.50 mH_2O	2.80 – 3.90 mH_2O
4	0.73 – 1.10 mH_2O	0.70 – 1.10 mH_2O	1.50 – 2.50 mH_2O	3.90 – 5.80 mH_2O
5	1.10 – 1.92 mH_2O	1.10 – 1.80 mH_2O	2.50 – 4.00mH_2O	5.80 – 9.90 mH_2O
6	1.92 – 3.10 mH_2O	1.80 – 3.00 mH_2O	4.00 – 6.00 mH_2O	9.90 – 15.30 mH_2O
7	3.10 – 3.50 mH_2O	3.00 – 4.80 mH_2O	6.00 – 10.00 mH_2O	15.30 – 25.10 mH_2O
8	NOT APPLICABLE	4.80 – 7.10 mH_2O	10.00 – 16.00 mH_2O	25.10 – 35.60 mH_2O

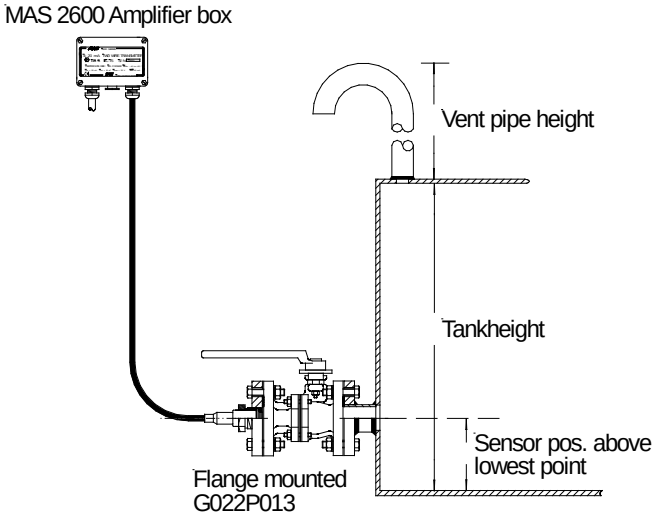
Absolute Transmitter:

The MAS 2600 Absolute Transmitter is available in two ranges.
The output signals are calibrated as follows:

Transducer type 4 : 0.8 - 3.5 bar abs
Transducer type 7 : 0.8 - 2.0 bar abs

Selecting the Measuring Range:

When selecting the measuring range it is important to consider the tank height, vent pipe height, the tank type and the specific gravity (SG) of the tank contents.
The transducer measures the height of the fluid (water gauge) from the transducer diaphragm to the surface of the fluid, including the fluid in the vent pipe.



To ensure measuring accuracy a transducer type within the range no. 4, 5, 6, 7 and 8 is recommended.

Guidelines for selection of transducer measuring ranges are set out in the following.

Selecting the Transducer Type:

Gauge and High Temperature Gauge Transducers:

The Gauge Transmitter is normally used on dry and pressure neutral locations.
The Gauge Transmitter is available in 4 ranges:

0-3.5 mH_2O.
0-7.0 mH_2O.
0-16.0 mH_2O.
0-35.0 mH_2O.

Absolute Transducers:

The Absolute Transmitter is typically used if the amplifier is exposed to water, e.g. on open deck. The Absolute Transmitter is available in 2 ranges: 0-20 and 0-35 mH_2O. In practice this means 10 mH_2O less than the nominal range because of the atmospheric pressure which must be taken into consideration when choosing the transducer.

A transducer with an effective range larger than the tank height should be selected.

Basic Rules:

1. The selected measuring range must be larger than the tank height.
2. The selected measuring range must be larger than $\frac{\text{tank height + vent pipe height}}{2}$

EXAMPLE: Tank height = 6 m
Vent pipe height = 14 m

1. The selected measuring range must be larger than 6 m due to the height of the tank.
2. The selected measuring range must be lager than $\frac{6+14}{2}$ = 10 m due to the total height of the tank and the vent pipe combined.

Select a transducer with a measuring range of 16 mH_2O as this is the next measuring range larger than 10 m.

Turn the range select switch on the amplifier to range No. 7.

Normally the selection of transducer, range select and calibration are done by DAMCOS.

Special consideration applies to e.g. forepeak tanks and draft measuring when selecting the measuring range of the transducer.

Forepeak Tank:

Transducer measuring range > tank height: Select the next measuring range.

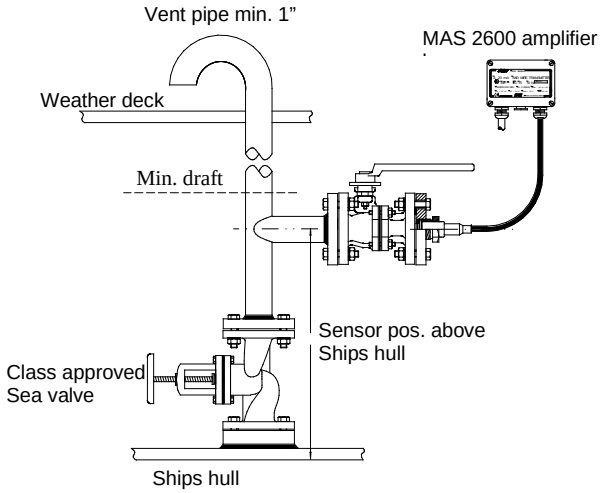
EXAMPLE: Tank height 12 m.

Based on the tank height a transducer with a measuring range of 16 mH_2O should be selected.

However, due to the dynamic conditions in the forepeak tank, a transducer with a measuring range of 35 mH_2O, i.e. the next in line, should be selected.

Turn amplifier range select switch to range No. 6.

Draft:



Transducer measuring range > max. draft minus sensor position.

This rule applies provided the transducer is mounted in accordance with the installation drawing for draft transmitters (vent pipe min. 1").

If the transducer is installed in tanks which may have excessive dynamic stresses such as e.g. high pump pressure, long bottomed tanks with a risk of slashing etc., contact Emerson Process Management Marine Solutions, Damcos.

Temperature Sensor MAS 2600-XXX-XX-X/XX

The transducer can be supplied with a built-in Pt100 temperature sensor. The temperature sensor will only give a proper reading, if the transducer is an internally mounted type.

0: Without temperature sensor.
1: With temperature sensor

Cable MAS 2600-XXX-XX-X/XX

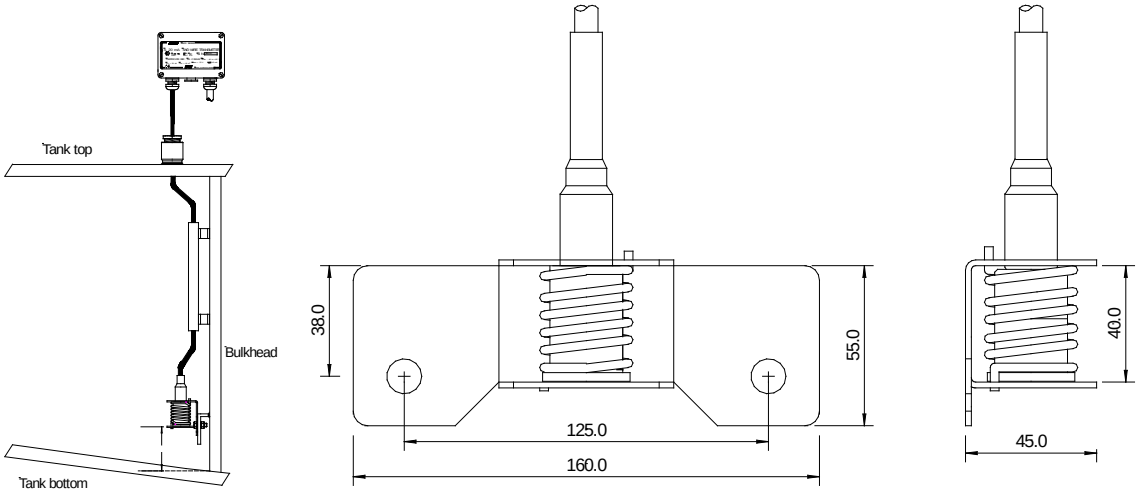
Two types of transducer cable is available. The standard cable for applications with temperatures never exceeding 80°C, and high temperature cable for applications with temperatures up to 125°C. The transducer cable is delivered in whole meters.

For further information require data sheet.

To make the MAS 2600 transmitter easy to install, and for later service purposes, the transducer cable should be as short as possible, though considering the position of the transducer and amplifier box.

Max. cable length: 300 m.
When installing in hazardous areas max. cable length: 75 m.

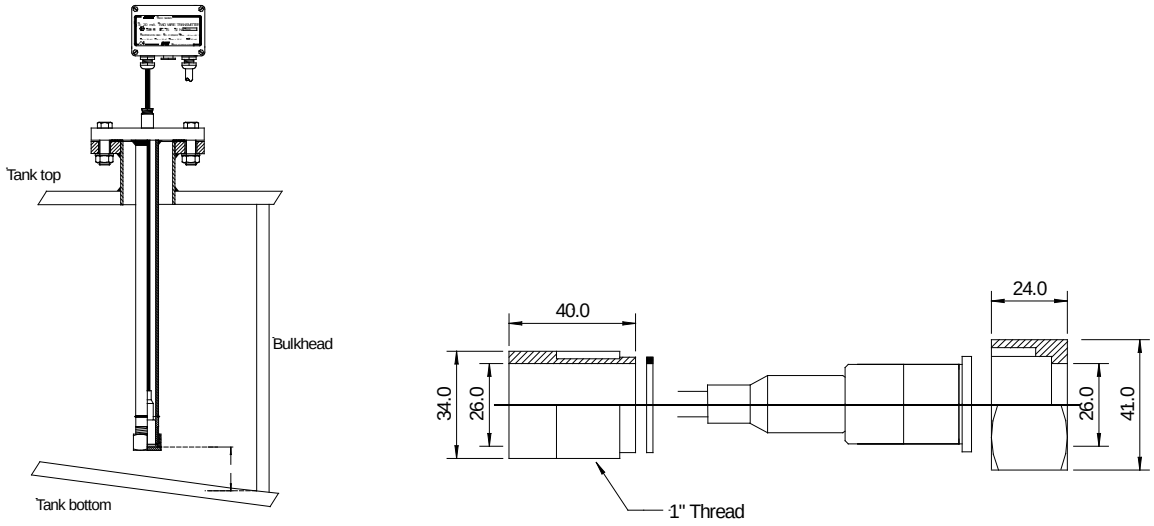
Brackets for Internal Mounting - drawing no. G022P010:



The brackets are U-shaped and manufactured of 2 mm SS 316L plated steel. Diameter of mounting holes: 11.5 mm.

The transducer is secured by means of a spring fitted into two holes in the “U” shape, and can be mounted/dismounted without the use of tools.

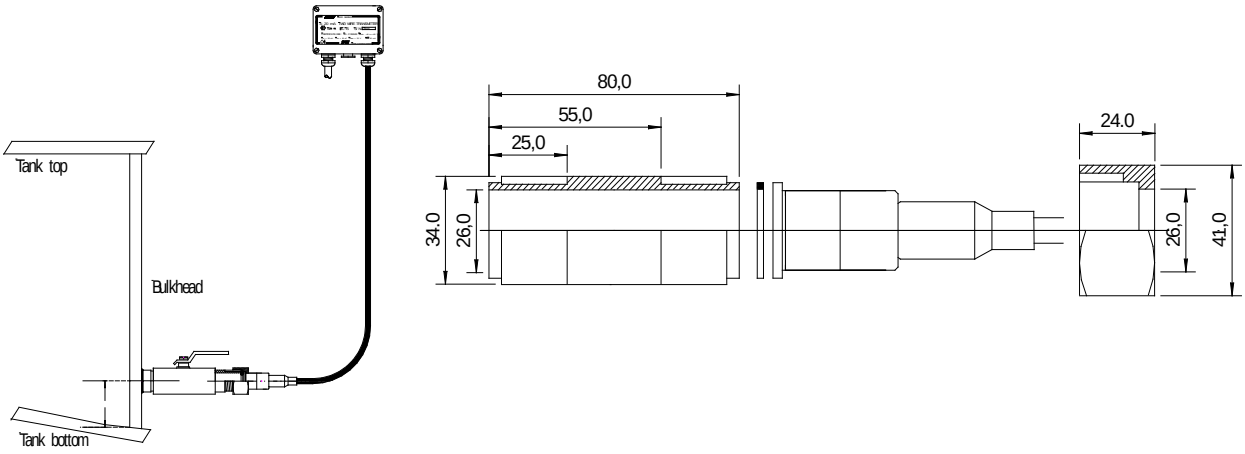
Pole Mounting - drawing no. G022P011:



The weldable collar and the nut are manufactured of SS 316L steel. The gaskets are made of nitrile rubber.

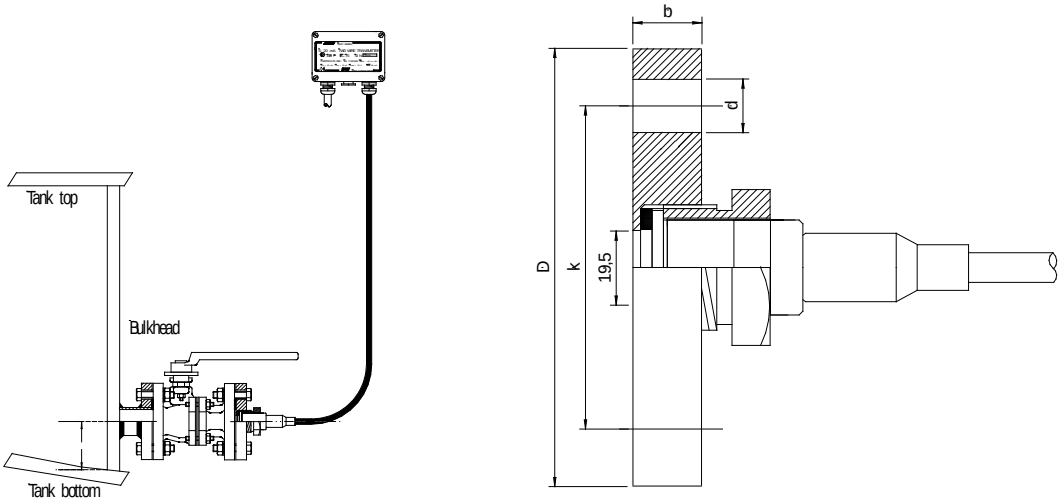
Note: Max torque 20 Nm (slightly tighten by the hand + 1/8-1/4 turn). Remember the gasket.

1” Pipe End Mounting - drawing no. G022P015:



The thread collar and the nut are manufactured of SS 316L steel. The gaskets are made of nitrile rubber.
Note: Max torque 20 Nm (slightly tighten by the hand + 1/8-1/4 turn). Remember the gasket.

Flange Mounting - drawing no. G022P013:

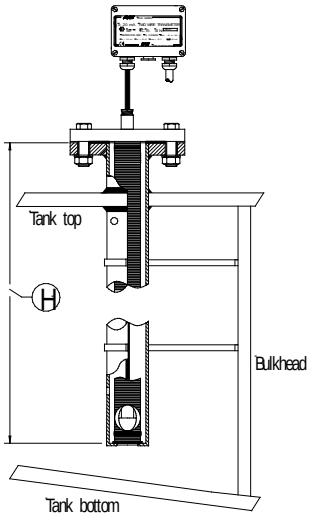


The standard transducer is supplied with DN25, DN40 or DN50 PN16 DIN2527 flange manufactured in AISI 316L steel.

DN	Flange			Bolts		
	D Mm	B mm	K Mm	No. of bolts	thread dia.	d mm
25	115	16	85	4	M12	14
40	150	16	110	4	M16	18
50	165	18	125	4	M16	18

Note: Max torque 20 Nm (slightly tighten by the hand + 1/8-1/4 turn). Remember the gasket.

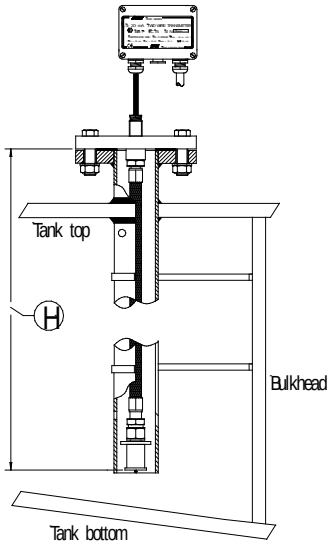
Flexible rubber tube mounting 80 ºC - drawing no. G022P001:



A top flange made of SS 316L connected to rubber tube by a tightening clip using a special tool. The opposite hose end covers the transducer body and is fixed by a tightening clip.

NB: When ordering this mounting type always specify length for the measurement of H cf. above drawing.

Flexible PTFE tube mounting 125ºC - drawing no. G022P021:

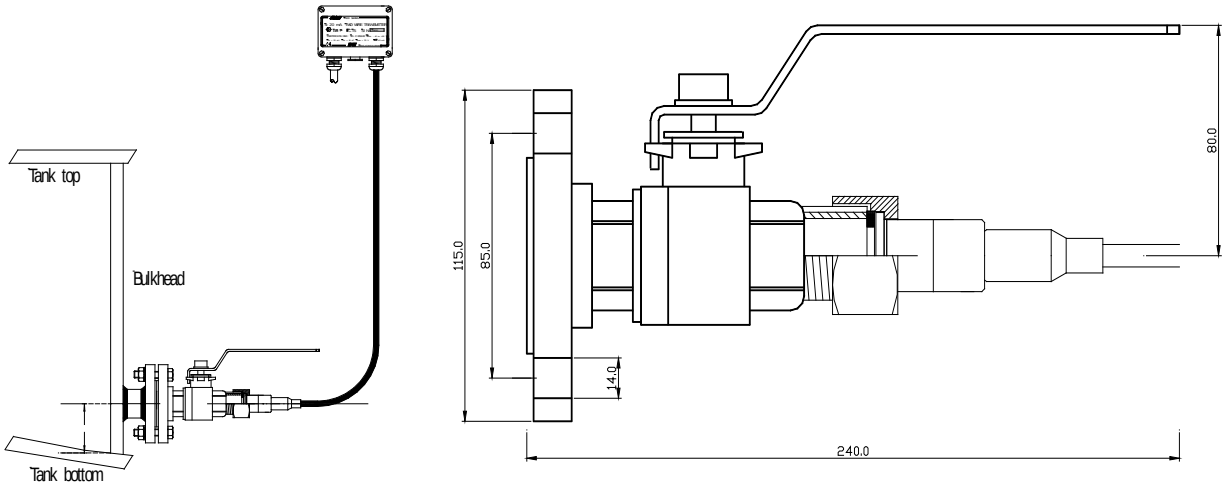


A top flange made of SS 316L connected to a Stainless Steel braided PTFE tube by fittings fixed to the tube by using special tools. A fitting in the opposite tube end is fixed to the transducer by means of nut and ferrules. Min. hose bending radius 130 mm.

NB: When ordering this mounting type always specify length for the measurement of H cf. above drawing.

*Note: This mounting type can only be assembled by Emerson Process Management Marine Solutions, Damcos because it requires special tools. The customer can exchange the MAS 2600 transmitter by ordering a G022B085 and a G022B082 together with the new MAS 2600 transducer. It must clearly be specified that it is a replacement for an MAS 2600 HXX-XX-**P**/XX.*

DN25 flange with 1" ball valve – drawing no. G022P019:



Flange, valve and nut are manufactured of SS 316L steel. The gaskets are made of nitrile rubber.

Note: Max torque 20 Nm (slightly tighten by the hand + 1/8-1/4 turn). Remember the gasket.

Amplifier Box MAS 2600-XXX-XX-X/XX

The MAS 2600 amplifier box is manufactured in polyester, which has the strength and stability of aluminium, insulation and resistance properties of plastics. Colour code RAL 7000.

The amplifier box is protected to the level of IP 56 and must be mounted outside the tank, e.g. in the engine room or other dry areas.

The amplifier box is available with a PG9 hole for silicone gel filling to protect the amplifier from moisture.

If the amplifier box is mounted on open deck with the risk of being over floated it is recommended to mount the amplifier box inside the special DAMCOS deck box made of stainless steel. For more information please contact DAMCOS.

0: Without amplifierbox.

1: Standard box with PG 11 / PG 11 cable glands. For cables with a diameter up to ø11.0.

2: Standard box with PG 11 / PG 13.5 cable glands. For cables with a diameter up to ø13.5.

3: Standard box with PG 11 / PG 16 cable glands. For cables with a diameter up to ø16.0.

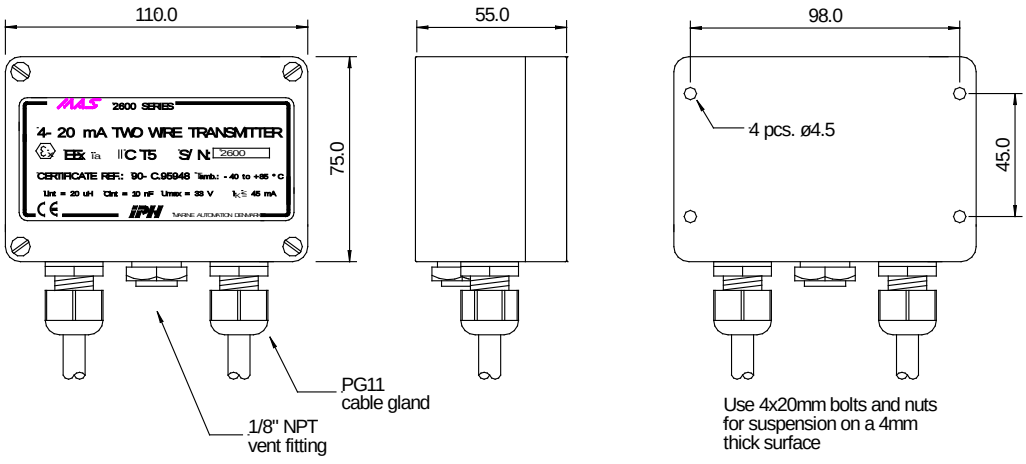
4: Silumin box.

5: Standard box with PG 13.5 / PG 13.5 cable glands. For cables with a diameter up to ø13.5.

6: Standard box with PG 11 / PG 11 cable glands and filling hole. For cables with a diameter up to ø11.0.

7: Standard box with PG 11 / PG 13.5 cable glands and filling hole. For cable with a diameter up to ø13.5.

8: Standard box with PG 11 / PG 16 cable glands and filling hole. For cable with a diameter up to ø16.0.



Amplifier PCB MAS 2600-XXX-XX-X/XX

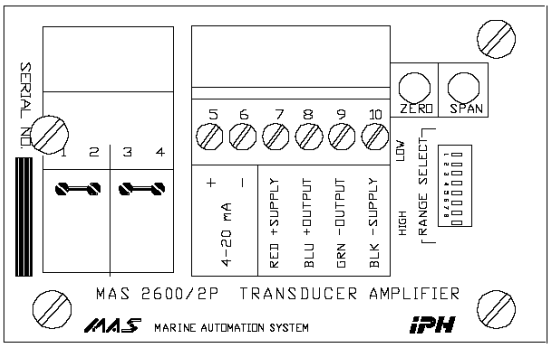
The PCB is available in different types for the different transducers, with or without terminals for Pt100 temperature sensor.

0: Without amplifier PCB.

P or S: Programmable output range. The amplifier can be calibrated to 4-20 mA output in whatever range wanted within the transducer range. Calibration is made by means of dip switches and potentiometers.

D or M: Differential output range. The output can be adjusted to 12 mA output with no pressure applied. With pressure or vacuum, the output goes against 20 mA and 4 mA respectively. Full-scale and zero point calibration by means of software, e.g. tank monitoring software.

- The types **S and M** are <u>with</u> terminals for temperature sensors.
- The types **P and D** are <u>without</u> terminals for temperature sensors.



Programmable Range (Type P)

Handling

The MAS 2600 transducer is a highly sensitive electronic piece of equipment and proper handling is most important.

To avoid damaging the transducers**:**

- **NEVER** lift by the cable if transducer is mounted with fittings.
- **NEVER** remove the protection cap in front of the diaphragm before installation.
- **NEVER** knock the transducer.
- **NEVER** apply pressure to the diaphragm in any way whatsoever, whether using fingers, tools or sharp objects.
- **NEVER** use sharp objects when cleaning the diaphragm.
- **NEVER** submerge the cable so that the breather tube is under water.
- **NEVER** bend the cable in a radius of less than 90 mm.

Installation

Prior to installation please check that:

- the serial numbers on the transducer, amplifier and lid of amplifier box agree. The serial numbers are to be found on the inside of the lid of the amplifier box on the bottom line - amplifier S/N and transducer S/N on the range label.

- the transducer is fitted in the correct tank.

- the transducer is correctly connected to the amplifier.
  NOTE: The white and brown wires in the transducer cable are only used when a Pt100 sensor is built into the transducer.

- all cable glands are properly secured to the amplifier box.

- the amplifier box is mounted in such a way that the breather tube cannot be flooded.

- the cable is fastened with cable clips with a distance of max. 50 cm.

- the cable isolation is not damaged (cracks, weld spatter, burns etc.).

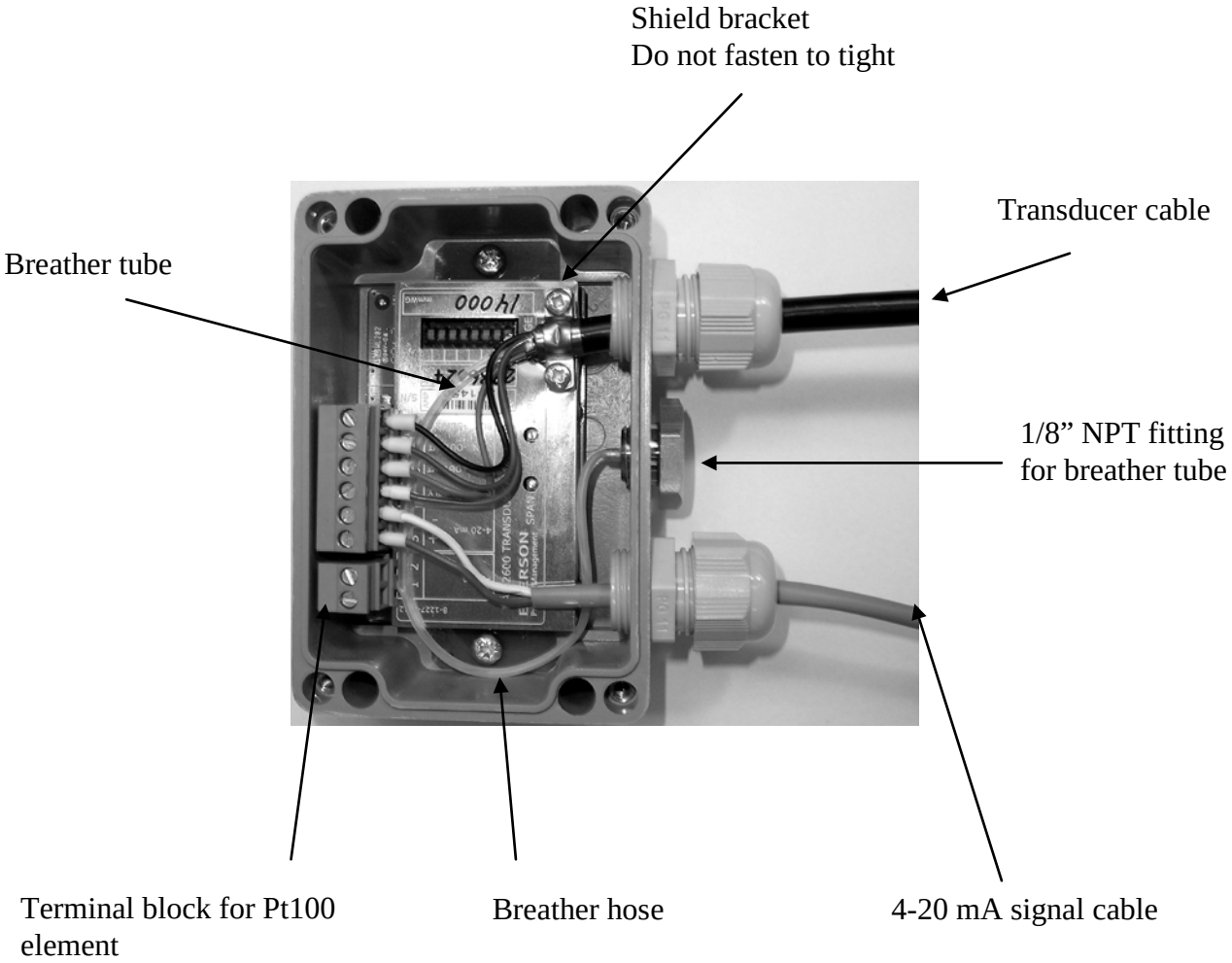
- shut-off valves can be either ball valves or other valves not generating over pressure exceeding 4 x the transducer range between valve seat and transducer when the valve is closed.

As for flange mounted applications it is recommended that a ball valve is fitted in the front of the transducer to facilitate testing and calibrating of the transmitter.

Using a shielded cable to the 4-20 mA signal, the shield should **not** be connected in the amplifier box but the earth terminal of the instrument.

Using a shielded cable ensures maximum protection against electric noise.

If the amplifier box is installed in an area with over pressure or negative pressure in relation to the atmospheric pressure in the tank, the breather tube must be directed to an area with atmospheric pressure equalling the pressure inside the tank. This applies to gauge transmitters only. For absolute transmitters this has no affect, due to the reference to absolute vacuum and not atmospheric pressure. This is also the reason why no breather tube is necessary.



Intrinsically Safe Installation

The MAS 2600 is designed for use in an approved intrinsically safe installation. The amplifier is fitted with a label describing the IS category:

EEx ia IIC T5 Tamb. = -40 to +85 °C

where

E : denotes the harmonised European Standard (CENELEC).

Ex ia : denotes the category of intrinsic safety, i.e. the system is incapable of causing ignition in normal operation or with any combination of up to two faults applied. This category will be adequate for use in zone 0, 1 and 2.

IIC : denotes the group of gases or vapours, e.g. hydrogen (detailed description in EN 50 020).

T5 : denotes the maximum surface temperature classification specified (T5: 100 °C).

Tamb : denotes the minimum and maximum ambient temperature permitted by the certificate.

Relevant intrinsic safety certificates to be supplied with the system units.

The certification of electric apparatus as intrinsically safe requires the apparatus to be designed and tested in accordance with approved drawings and the apparatus to be installed in accordance with approved block schematic diagrams.

Before installing intrinsically safe units within an approved installation, it is essential to ensure that there are no deviations from the conditions of the order or the requirements of the approved block schematic diagram and the following related instructions:

1. No circuits other than those shown on the drawing are permitted. There must be no interconnection to any other circuits.

2. The intrinsically safe cabling must not be connected to non-intrinsically safe circuits, through any plug, socket or other form of electric connector containing the cable.

3. Adequate precautions must be taken to prevent danger arising from the charging of the intrinsically safe circuit by the contact leakage or inductance from any other circuit.

4. The intrinsically safe circuit must be adequately insulated from earth in the hazardous area and the insulation of all cabling must be at least 500 V r.m.s.

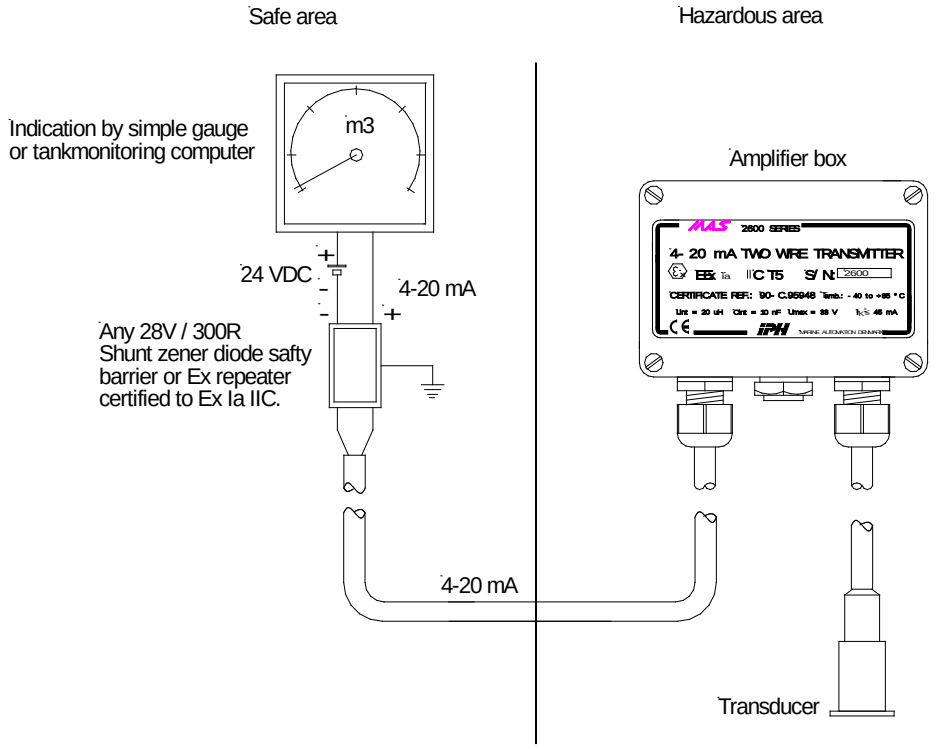
5. The safety barrier (zener barrier) must be placed in a safe area and be mounted within a protective enclosure with a protection degree, at least equal to IP 20.

6. The cable between the safety barrier and the amplifier should be provided with a cable shield which is connected to earth at the zener barrier. The impedance between the safety barrier earth rail and a secure bond to the hull must not exceed 1 ohm.

7. Safe area apparatus must not be supplied from, nor contain, a source of potential with respect to earth under normal or abnormal conditions exceeding 250V r.m.s. or 250 V d.c.

8. The inductance/resistance ratio, total inductance and total capacitance, of the cable must not exceed the values stated by the manufacturer of the approved safety barriers.

Reference is made to manufacturer instructions of zener barriers and to the rules in force at the time in question concerning intrinsically safe area installation.



Testing and Recalibrating

Testing

Before dispatch, the MAS 2600 transmitter is calibrated in accordance with the requirements specified in the order.

The transducer and the amplifier are calibrated together and must, therefore, always be used together.

A programmable measuring range transmitter will in conditions of no pressure (empty tank) give an output signal of 4 mA, and in conditions of maximum pressure (full tank) an output signal of 20 mA.

The transmitter should be tested by applying to the transducer a known pressure from a calibrator and reading the equivalent milliampere signal on a milliampmeter.

The above-mentioned applies to the gauges transmitter only. For absolute transmitters the output signal will be higher than 4 mA, because it is calibrated for 4 mA at 0.8 bar abs. The output signal will typically be 5-7.5 mA in atmospheric pressure, depending on the transducer range and the actual atmospheric pressure. Maximum output signal 20 mA, will be at the transducers absolute range.

Recalibrating Gauge Transmitter using Test Cup type G022S100

When recalibrating the MAS 2600 Gauge Transmitter a pressure calibrator with a range of -1 to 3.5 bar should be used. It should have an accuracy of 0.05% FS or better, as well as a 4½ digit milliampmeter.

1. Set the calibrator to pressure mode.

2. Connect the pressure calibrator to the transducer via MAS 2600 Test Cup, type G022S100.

3. Check that the range select switch on the amplifier is correctly set.

4. In conditions of no pressure (atmospheric pressure) the output signal should be adjusted to 4.00 mA on the zero potentiometer.

5. Increase the pressure to maximum and adjust the output signal to 20.00 mA on the span potentiometer.

6. Remove the pressure and check the zero point

7. Check the linearity at 0-25-50-75 and 100% of the measuring range.

8. If necessary, repeat the steps 4 to 7.

NOTE: If there is no zero and span potentiometer, the unit is a ‘fixed measuring range’ unit. This unit cannot be calibrated.

Recalibrating Gauge Transmitter using Vacuum (for gauge transmitters only)

An internally mounted transducer can also be recalibrated by using vacuum.

1. Check that the tank is empty.

2. Check that the range select switch on the amplifier is correctly set.

3. Set the calibrator to vacuum mode.

4. Connect the hose from the calibrator to the breather tube from the transducer cable.

5. In conditions of no pressure the output signal should be adjusted to 4.00 mA on the zero potentiometer.

6. Increase the vacuum equal to the maximum height of the fluid (water gauge) and adjust the output signal to 20.00 mA on the span potentiometer.

7. Remove the vacuum and check the zero point.

8. Check the linearity at 0-25-50-75 and 100% of the measuring range.

9. If necessary, repeat the steps 5 to 8.

NOTE: If the calibrated maximum water gauge is greater than the maximum water gauge that can be generated by the vacuum calibrator, the proportional mA output signal equal to the maximum vacuum signal should be calculated.

EXAMPLE: If the full-scale of the transmitter is 15 mH_2O, and the maximum capacity of the vacuum calibrator is 7.5 mH_2O, the mA output signal at 7.5 mH_2O is calculated as:

15 mH_2O = 20 mA and 0 mH_2O = 4 mA

$$7.5\ mH_2O = 4 + \frac{(20-4)*7.5}{15} = 12\,mA$$

The span potentiometer is adjusted so that the output signal shows 12 mA at 7.5 mH_2O.

Recalibrating the Absolute Transmitter using Test Cup type G022S100

When recalibrating the MAS 2600 Absolute Transmitter a pressure calibrator with a range of -1 to 3.5 bar should be used. It should have an accuracy of 0.05% FS or better, as well as a 4½ digit milliampmeter. If a calibrator without reference transmitter is used, the atmospheric pressure must be known to calculate the correction.

Atmospheric pressure and *Transducer range* to be entered into the formulas as mbar.

1. The calibrator with the output selector switch set to pressure mode is connected to the MAS 2600 transmitter via a Test Cup, type G022S100.

2. Check the transducer range.
   The transducer range is indicated on the lid inside the amplifier box.

3. Calculate output signal in conditions of no pressure (atmospheric pressure), using bellow formula. The output signal should be adjusted to the calculated value on the zero potentiometer.

$$\text{mA @ Atmospheric pressure} = 4 + \frac{16*(Atm.\,press - 800)}{Trd.range - 800}$$

4. Calculate the pressure for maximum output signal, using the following formula.
   $\text{mbarg @ 20 mA} = Trd.range - Atm.\,press$

   Increase the pressure to calculated pressure and adjust the output signal to 20.00 mA on the span potentiometer.

5. Remove the pressure and check the zero point.

6. Check the linearity at 0-25-50-75 and 100% of the measuring range.

   Output signal at different pressures *P* can be calculated, using the following formula.

$$\text{mA @ } P \text{ mbarg} = 4 + \frac{16*(Atm.\,press - 800 + P)}{Trd.range - 800}$$

7. If necessary, repeat the steps 3 to 6.

EXAMPLE: If the range of the transducer is 3.5 bar abs and the atmospheric pressure is 1005 mbar.

Calculated output at atmospheric pressure:

$$\text{mA @ Atm.press} = 4 + \frac{16 * (1005 - 800)}{3500 - 800} = 5.215 \text{ mA}$$

Calculated applied pressure for maximum output:

$$\text{mbarg @ 20 mA} = 3500 - 1005 = 2495 \text{ mbarg}$$

Calculated pressure at 50% of the transducer range:

$$\text{mA @ } P \text{ mbarg} = 4 + \frac{16 * (1005 - 800 + 1750)}{3500 - 800} = 15.585 \text{ mA}$$

Maintenance and Trouble Shooting

Maintenance

Damcos recommends that the following to be checked annually:

1. Visual inspection of the cable, transducer and amplifier.

2. Compare signal with e.g. hand sounding, and if necessary perform a zero and full-scale calibration.

Trouble Shooting

If the MAS 2600 transmitter is not functioning in accordance with Emerson Process Management Marine Solutions, Damcos instructions, check that:

1. the 24 VDC power supply has been correctly connected, and is between 14-33 VDC.

2. the 4 - 20 mA output signal is functioning (compared with e.g. hand sounding).

3. the transducer cable has been correctly fitted and the shield connected to the shield terminal in the amplifier box.

4. the diaphragm has not been damaged.

If this does not succeed, fill in the test sheet on page 27 and submit this to our Service department fax no.: +45 5578 7272.

When contacting our Service department please specify the serial numbers of both transducer and amplifier.

The test sheet will be examined to see whether it can be established that the transmitter is broken or not.

When returning a defective MAS 2600 transmitter for repairs, please ensure that:

- The transducer diaphragm is protected against blows of any kind.
- Both the transducer and the amplifier are returned.
- A detailed description of the fault is enclosed.

MAS2600 Test sheet

ATT.: Emerson Process Management
Marine Solutions
Damcos A/S, Service Department
FAX.: +45 5578 7272

Name:		
Ship name:	Yard:	NB No:

MAS2600:

Transducer serial no.:			Amplifier serial no.:	
Tank name:				
Liquid in tank	HFO:	DO:	Ballast:	Other:
The tank is	Full:	Empty:		Other:

Measurements:

1	Measure voltage between terminal 5 and 6	V DC	Voltage should be in the range 14 to 33 V DC. Check power supply.
2	Measure ripple voltage between terminal 5 and 6	V AC	Voltage must not exceed 2 V AC. Check power supply.
3	Measure sensor excitation voltage between terminal 7 and 10	V DC	Voltage should be in the range 3.0 to 6.2 V DC
4	Measure sensor excitation voltage between terminal 8 and 9	mV DC	Voltage should be in the range -15 to 100 mV DC
5	Measure current in supply lead to terminal 5	mA DC	Current should be in the range 4 to 20 mA and the same value as measured in point 6. If not the amplifier may be defect.
6	Measure current in supply lead to terminal 6	mA DC	Current should be in the range 4 to 20 mA and the same value as measured in point 5. If not the amplifier may be defect.
7	Measure sensor resistance with sensor cable unconnected		If the resistance measured is less that 1 M Ohm the sensor is defect.
	Terminal 7 to cable shield	M Ohm	
	Terminal 8 to cable shield	M Ohm	
	Terminal 9 to cable shield	M Ohm	
	Terminal 10 to cable shield	M Ohm	
8	Measure sensor bridge resistance with sensor cable unconnected		If the resistance measured is less than 1 K Ohm or greater that 50 K Ohm the sensor is defect.
	Terminal 7 to Terminal 8	K Ohm	
	Terminal 7 to Terminal 9	K Ohm	
	Terminal 7 to Terminal 10	K Ohm	
	Terminal 8 to Terminal 9	K Ohm	
	Terminal 8 to Terminal 10	K Ohm	
	Terminal 9 to Terminal 10	K Ohm	
9	Visual inspection of the transmitter: Is the cable damaged? Are there sharp bends on the cable? Are there moisture/liquids in the breather tube? Is the diaphragm damaged?		
10	Comments:		